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(54) **EXTENSIBLE IMPLANTABLE MEDICAL LEAD WITH BRAIDED CONDUCTORS**

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**A61N 1/05** (2006.01)

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See application file for complete search history.

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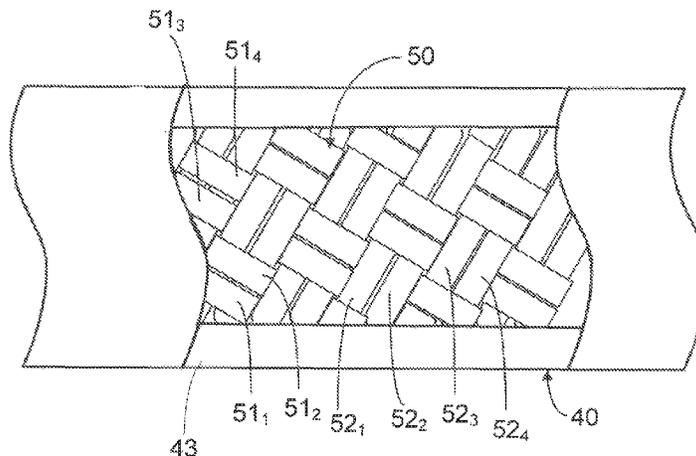
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(57) **ABSTRACT**

An extensible implantable electrical lead includes a lead body having a proximal end and a distal end. The lead body is formed of a polymeric material that is extensible between a first length and a second length. A plurality of electrical conductors are disposed within the lead body and extend between the proximal end and the distal end. The plurality of electrical conductors are each electrically insulated from each other and form a braided coil extending between the proximal end and the distal end. The plurality of electrical conductors are electrically insulated and separated from each other and have a braided coil diameter.

**20 Claims, 5 Drawing Sheets**



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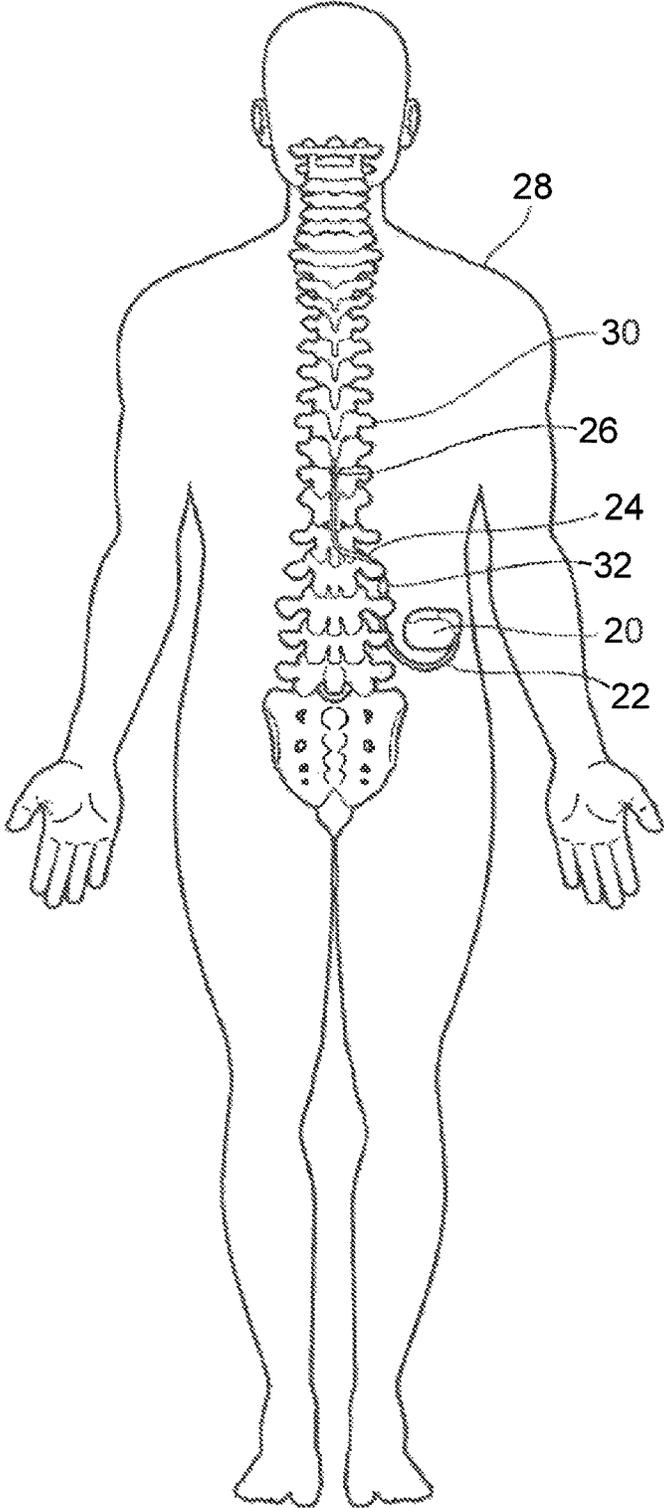


FIG. 1

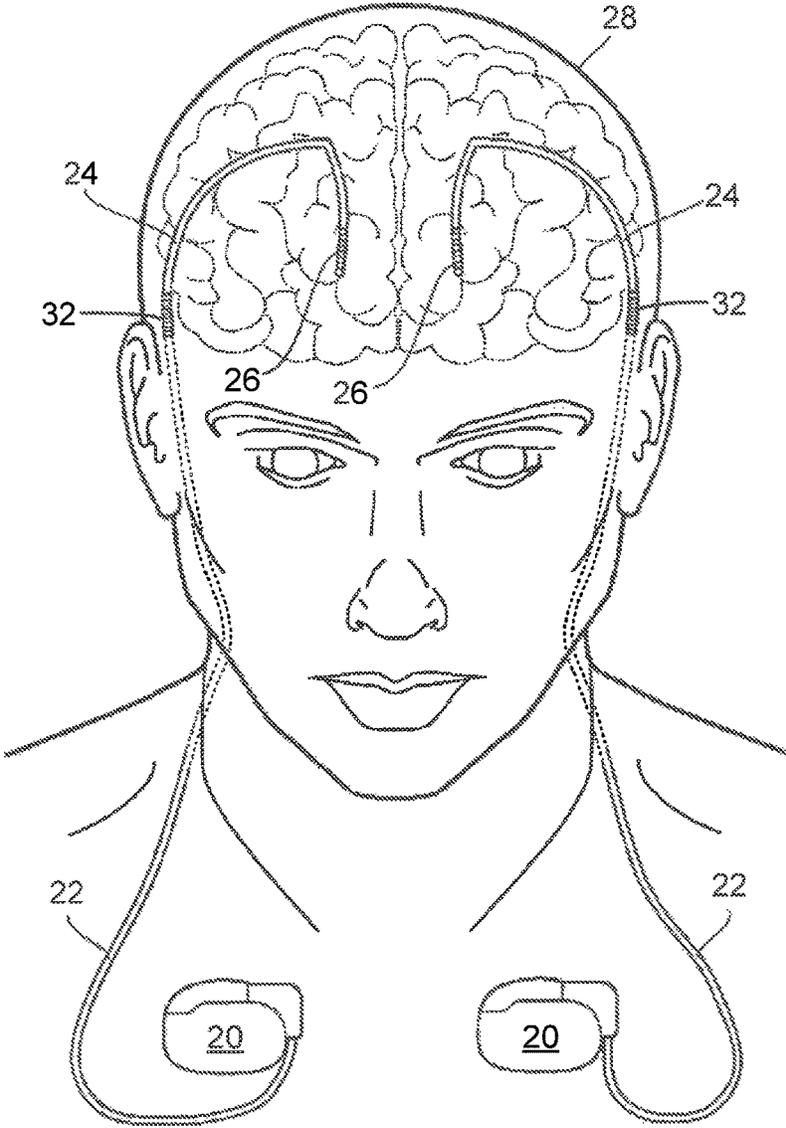


FIG. 2

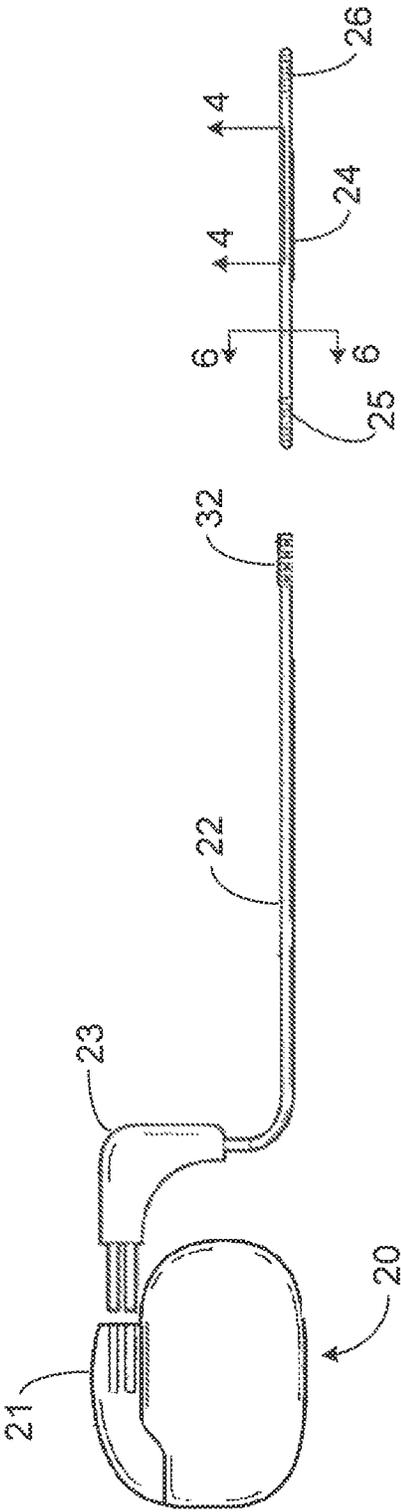


FIG. 3

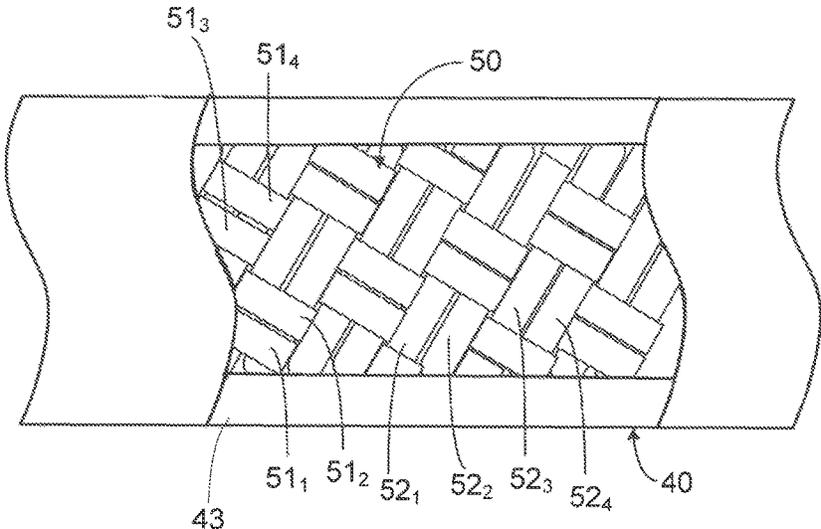


FIG. 4

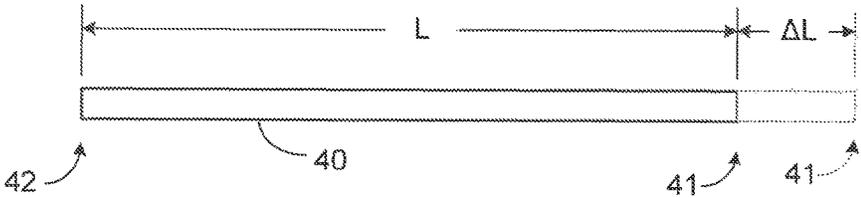


FIG. 5

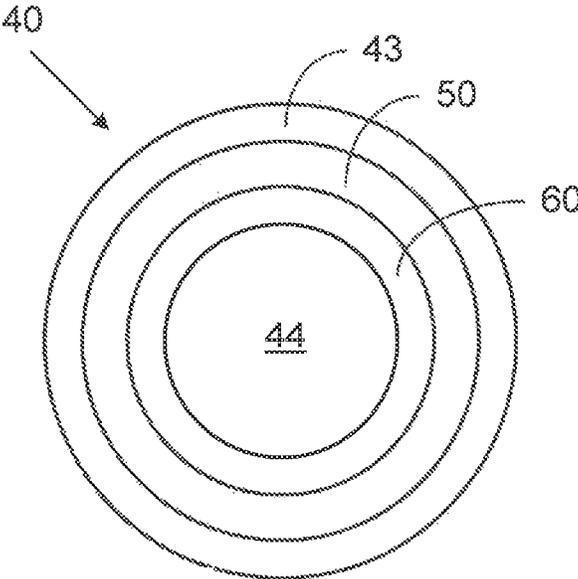


FIG. 6

## EXTENSIBLE IMPLANTABLE MEDICAL LEAD WITH BRAIDED CONDUCTORS

This application claims the benefit of and is a U.S. National Stage filing under 35 U.S.C. 371 of copending PCT Application Serial No. PCT/US2009/031788, filed Jan. 23, 2009, which in turn claims the benefit of U.S. Provisional Application No. 61/045,646, filed Apr. 17, 2008, "Extensible Implantable Medical Lead with Braided Conductors," the disclosure of all of the above which is incorporated by reference herein in its entirety.

### FIELD

The present disclosure relates to extensible implantable medical leads with braided conductors.

### BACKGROUND

Implantable medical devices are commonly used today to treat patients suffering from various ailments. Such implantable devices may be utilized to treat conditions such as pain, incontinence, sleep disorders, and movement disorders such as Parkinson's disease and epilepsy, for example. Such therapies also appear promising in the treatment of a variety of psychological, emotional, and other physiological conditions.

One known type of implantable medical device, a neurostimulator, delivers mild electrical impulses to neural tissue using an electrical lead. For example, to treat pain, electrical impulses may be directed to specific sites. Such neurostimulation may result in effective pain relief and a reduction in the use of pain medications and/or repeat surgeries.

Typically, such devices are totally implantable and may be controlled by a physician or a patient through the use of an external programmer. Current systems generally include a primary cell neurostimulator, a lead extension, and a stimulation lead, and two particular applications of systems may be referred to as: (1) spinal cord stimulation; and (2) deep brain stimulation.

A spinal cord stimulator may be implanted in the abdomen, upper buttock, or pectoral region of a patient and may include at least one extension running from the neurostimulator to the lead or leads which are placed somewhere along the spinal cord. Each of the leads (to be discussed in detail hereinafter) often includes from one to sixteen, or more electrodes. Each extension (likewise to be discussed in detail below hereinafter) is plugged into or connected to the neurostimulator at a proximal end thereof and is coupled to and interfaces with the lead or leads at a distal end of the extension or extensions.

The implanted neurostimulation system is configured to send mild electrical pulses to the spinal cord. These electrical pulses are delivered through the lead or leads to regions near the spinal cord or the nerve selected for stimulation. Each lead includes a small insulated wire coupled to an electrode at the distal end thereof through which the electrical stimulation is delivered. The lead may also include a corresponding number of internal wires to provide separate electrical connection to each electrode such that each electrode may be selectively used to provide stimulation. Connection of the lead to an extension may be accomplished by means of a connector block including, for example, a series or combination of set-screws, ball-seals, etc. The leads are inserted into metal set screw blocks, and metal set screws are manipulated to press the contacts against the blocks to clamp

them in place and provide an electrical connection between the lead wires and the blocks.

A deep brain stimulation system includes similar components (i.e. a neurostimulator, at least one extension, and at least one stimulation lead) and may be utilized to provide a variety of different types of electrical stimulation to reduce the occurrence or effects of Parkinson's disease, epileptic seizures, or other undesirable neurological events. In this case, the neurostimulator may be implanted into the pectoral region of the patient. The extension or extensions may extend up through the patient's neck, and the leads/electrodes are implanted in the brain. The leads may interface with the extension just above the ear on both sides of the patient. The distal end of the lead may contain from four to sixteen, or more electrodes and, as was the case previously, the proximal end of the lead may connect to the distal end of the extension and held in place by set screws. The proximal portion of the extension plugs into the connector block of the neurostimulator.

Both of the spinal cord stimulation and deep brain stimulation implanted systems traverse portions of the human body that stretch and relax. To account for this stretching and relaxing, the lead and lead extension can be looped to allow for stretching and relaxing with the human body.

### BRIEF SUMMARY

The present disclosure relates to extensible implantable medical leads with braided conductors.

In an exemplary embodiment, an extensible implantable electrical lead includes a lead body having a proximal end and a distal end. The lead body is formed of a polymeric material that is extensible between a first length and a second length. A plurality of electrical conductors are disposed within the lead body and extend between the proximal end and the distal end. The plurality of electrical conductors are each electrically insulated from each other and form a braided coil extending between the proximal end and the distal end. The plurality of electrical conductors are electrically insulated and separated from each other and have a braided coil diameter.

In another exemplary embodiment, an implantable neurostimulation system includes a neurostimulating device and an extensible electrical lead, described herein, electrically coupled to the neurostimulating device.

In another exemplary embodiment, a method includes applying a force of 5 N or less to a proximal end and a distal end of an extensible electrical lead having a first length. The force increases the first length of the extensible electrical lead by at least 10%. Then the force is removed from the extensible electrical lead to return the extensible electrical lead to its first length.

### BRIEF DESCRIPTION OF THE DRAWING

The disclosure may be more completely understood in consideration of the following detailed description of various embodiments of the disclosure in connection with the accompanying drawings, in which:

FIG. 1 is a schematic diagram of a spinal cord stimulation system implanted within a human body;

FIG. 2 is a schematic diagram of a deep brain stimulation system implanted within a human body;

FIG. 3 is a schematic exploded view of an implantable active medical device;

FIG. 4 is a schematic partial cross-sectional diagram of an exemplary extensible lead taken along line 4-4 of FIG. 3;

FIG. 5 is a schematic diagram of the extensible lead in a stretched state and a relaxed state; and

FIG. 6 is a schematic cross-sectional diagram of an exemplary extensible lead taken along line 6-6 of FIG. 3.

The figures are not necessarily to scale. Like numbers used in the figures refer to like components. However, it will be understood that the use of a number to refer to a component in a given figure is not intended to limit the component in another figure labeled with the same number.

#### DETAILED DESCRIPTION

In the following description, reference is made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration several specific embodiments. It is to be understood that other embodiments are contemplated and may be made without departing from the scope or spirit of the present disclosure. The following detailed description, therefore, is not to be taken in a limiting sense.

All scientific and technical terms used herein have meanings commonly used in the art unless otherwise specified. The definitions provided herein are to facilitate understanding of certain terms used frequently herein and are not meant to limit the scope of the present disclosure.

Unless otherwise indicated, all numbers expressing feature sizes, amounts, and physical properties used in the specification and claims are to be understood as being modified in all instances by the term "about." Accordingly, unless indicated to the contrary, the numerical parameters set forth in the foregoing specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by those skilled in the art utilizing the teachings disclosed herein.

The term "lead" refers to either or both a lead and a lead extension as described below, unless otherwise noted.

The recitation of numerical ranges by endpoints includes all numbers subsumed within that range (e.g. 1 to 5 includes 1, 1.5, 2, 2.75, 3, 3.80, 4, and 5) and any range within that range.

As used in this specification and the appended claims, the singular forms "a", "an", and "the" encompass embodiments having plural referents, unless the content clearly dictates otherwise. As used in this specification and the appended claims, the term "or" is generally employed in its sense including "and/or" unless the content clearly dictates otherwise.

The term "active implantable medical device" or "implantable signal generator" are used interchangeably and includes, for example, a cardiac pacemaker, an implantable defibrillator, a congestive heart failure device, a hearing implant, a cochlear implant, a neurostimulator, a drug pump, a ventricular assist device, an insulin pump, a spinal cord stimulator, an implantable sensing system, a deep brain stimulator, an artificial heart, an incontinence device, a vagus nerve stimulator, a bone growth stimulator, a gastric pacemaker, and the like.

The present disclosure relates to extensible implantable medical leads with braided conductors where the lead or lead extension is extensible between a stretched state and a relaxed state. These extensible leads are particularly useful as implantable leads for neurostimulator applications where the leads provide spinal cord stimulation and deep brain stimulation and traverse portions of the human body that stretch and relax, though the leads are not limited to such applications. To account for this stretching and relaxing within the patient, the lead is repeatedly extensible. The

extensible leads described herein are formed by at least a plurality of electrical conductors that are separated and insulated from each other and form a braided coil between a proximal end and a distal end of the extensible lead. The braided conductor coil is disposed within a stretchable or extensible outer sheath that has an extensibility of at least 10% or at least 20% or at least 25%, or more. Thus, the extensible lead can be stretched by at least 10% or at least 20% or at least 25%, or more (when exposed to a force of 5 N or less) and return to its original length when relaxed. While the present disclosure is not so limited, an appreciation of various aspects of the disclosure will be gained through a discussion of the examples provided below.

FIG. 1 is a schematic diagram of a spinal cord stimulation system implanted within a human body or patient 28. The implanted spinal cord stimulation system includes an active medical device 20 such as a neurostimulator. The active medical device 20 is coupled to a lead extension 22 having a proximal end coupled to the active medical device 20, and a lead 24 having a proximal end coupled to a distal end or lead connector 32 of the lead extension 22 and a distal end of the lead 24 coupled to one or more electrodes 26.

In some embodiments, the lead 24 proximal end is coupled to the active medical device 20, without a need for the lead extension 22. The spinal cord neurostimulator 20 is illustrated being implanted within the torso or abdomen of the patient or human body 28. The lead 24 is shown placed somewhere along the spinal cord 30. In many embodiments, the active medical device 20 has one or two leads 24 each having four to sixteen, or more, electrodes.

Such a system may also include a physician programmer and a patient programmer (not shown). The active medical device 20 can be considered to be an implantable signal generator of the type available from Medtronic, Inc., and capable of generating multiple signals occurring either simultaneously or one signal shifting in time with respect to the other, and having independently varying amplitudes and signal widths. The active medical device 20 contains a power source and the electronics for sending precise, electrical signals to the patient to provide the desired treatment therapy. While the active medical device 20, in many embodiments, provides electrical stimulation by way of signals, other forms of stimulation may be used as continuous electrical stimulation.

FIG. 2 is a schematic diagram of a deep brain stimulation system implanted within a patient or human body 28. The implanted deep brain stimulation system includes an active medical device 20 such as a neurostimulator. The active medical device 20 is coupled to a lead extension 22 having a proximal end coupled to the active medical device 20, and a lead 24 having a proximal end coupled to a distal end or lead connector 32 of the lead extension 22 and a distal end of the lead 24 coupled to one or more electrodes 26.

In some embodiments, the lead 24 proximal end is coupled to the active medical device 20, without a need for the lead extension 22. The deep brain neurostimulator 20 is illustrated being implanted within the pectoral region of the patient or human body 28. The lead 24 is shown placed somewhere on or within the brain. In many embodiments, the active medical device 20 has one or two leads 24 each having four to sixteen, or more, electrodes.

Such a system may also include a physician programmer and a patient programmer (not shown). The active medical device 20 can be considered to be an implantable signal generator of the type available from Medtronic, Inc. and capable of generating multiple signals occurring either simultaneously or one signal shifting in time with respect to

the other, and having independently varying amplitudes and signal widths. The active medical device **20** contains a power source and the electronics for sending precise, electrical signals to the patient to provide the desired treatment therapy. While the active medical device **20**, in many 5 embodiments, provides electrical stimulation by way of signals, other forms of stimulation may be used as continuous electrical stimulation.

FIG. **3** is a schematic exploded view of the implantable stimulation system described above that includes an exemplary lead extension **22** configured to be physically and electrically coupled between a neurostimulator **20** and lead **24**. The implantable stimulation system described herein allows individual contacts **26** at the distal end of the lead **24** to be addressed individually by the neurostimulator **20** via 15 the individual insulated electrical conductor extending through the lead **24** as described below.

A proximal portion of the lead extension **22** includes a connector **23** configured to be received or plugged into connector block **21** of neurostimulator **20**. A distal end of the lead extension **22** includes a lead connector **32** including internal contacts configured to receive a proximal end of the lead **24** having contacts **25** thereon.

The lead **24** includes a plurality of insulated electrical conductors each coupled at their proximal end to a lead connector **32** via contacts **25** at its proximal end and to contacts/electrodes **26** at its distal end. Some leads are designed to be inserted into a patient percutaneously and some are designed to be surgically implanted. In some 25 embodiments, the lead **24** may include a paddle (not shown) at its distant end for housing electrodes **26**. In some embodiments, electrodes **26** may include one or more ring contacts at the distal end of lead **24**. Each contact is electrically coupled to a single insulated electrical conductor extending through the lead **24** as described below.

The lead **24** and/or lead extension **22** has a body formed of an extensible polymeric material that allows the lead **24** and/or lead extension **22** to stretch and relax at least 10%, or least 20%, or at least 25%, or at least 50%, as illustrated in FIG. **5** and return to its original or relaxed length **L**. In some 40 exemplary embodiments, the extensible polymeric material is silicone and the insulated electrical conductor are configured to allow the lead **24** and/or lead extension **22** to stretch and relax at least 10%, or least 20%, or at least 25%, or at least 50%, as illustrated in FIG. **5**. The extensibility values reported herein are based on an applied force of 5 N or less.

FIG. **4** is a schematic partial cross-sectional diagram of the extensible lead taken along line 4-4 of FIG. **3**. FIG. **5** is a schematic diagram of the extensible lead in a stretched state and a relaxed state. The extensible lead includes a lead body **40** extending between a proximal end **42** and a distal end **41**. FIG. **6** is a schematic cross-sectional diagram of the extensible lead taken along line 6-6 of FIG. **3**.

The lead body **40** is formed of a polymeric material that is extensible between a first length **L** and a second length  $L+\Delta L$ , where the second length is greater than the first length by at least 10%, or least 20%, or at least 25%, or at least 50%. This increase in length is accomplished by application of a force of 5 N or less. Upon removal of the force, the lead body **40** relaxes, contracts, or returns to its 60 original length **L**. The lead body **40** can be cycled between the first length and the second length thousands of times or more.

The lead body **40** can include an outer sheath **43** surrounding the braided coil **50**. In many exemplary embodiments, the lead body **40** includes an inner sheath **60** disposed within the lumen of the braided coil **50**. FIG. **6** illustrated the

configuration of the outer sheath **43**, the braided coil **50** and the inner sheath **60** all in co-axial relation to each other. An inner lumen **44** can form a void or be filled with an extensible polymeric material.

In some exemplary embodiments, the outer sheath **43**, braided coil **50**, and inner sheath **60** are fixed at the proximal end **42** and a distal end **41** of the lead body **40**. In many 5 embodiments the outer sheath **43** (and optionally inner sheath **60**) is loosely disposed about or within the braided coil **50** between the proximal end **42** and a distal end **41** of the lead body **40**.

In many embodiments, the extensibility of the sheaths **43**, **60** substantially match the stretchability of the braided coil **50**. The sheaths **43**, **60** are formed of an extensible polymeric material that allows the lead body **40** to stretch and relax at least 10%, or least 20%, or at least 25%, or at least 50%, as illustrated in FIG. **5**. In many embodiments, the extensible polymeric material is silicone and the insulated electrical conductors are configured to allow the lead body **40** to stretch and relax at least 10%, or least 20%, or at least 25%, or at least 50%, as illustrated in FIG. **5**. The inner sheath **60** and or outer sheath **43** can assist in the returning the braided coil **50** to its relaxed (larger diameter) state after the braided coil **50** has been stretched (to a smaller diameter). Thus, the braided coil **50** can operate in a manner similar to devices known as a "finger trap" where pulling on the ends of the braided coil **50** causes the coil to decrease in diameter and then pushing on the ends of the braided coil **50** causes the coil to increase in diameter.

A plurality of electrical conductors **51<sub>1</sub>**, **51<sub>2</sub>**, **51<sub>3</sub>**, **51<sub>4</sub>**, **52<sub>1</sub>**, **52<sub>2</sub>**, **52<sub>3</sub>**, **52<sub>4</sub>** are disposed within the lead body **40** and extending between the proximal end and the distal end of the lead body **40**. The plurality of electrical conductors **51<sub>1</sub>**, **51<sub>2</sub>**, **51<sub>3</sub>**, **51<sub>4</sub>**, **52<sub>1</sub>**, **52<sub>2</sub>**, **52<sub>3</sub>**, **52<sub>4</sub>** are each electrically insulated 35 from each other and form a braided coil **50** from the proximal end to the distal end.

The braided coil **50** can have any useful diameter such as, for example, from 1800 to 2500 micrometers. The braided coil **50** is formed by winding and braiding the individual insulated conductors **51<sub>1</sub>**, **51<sub>2</sub>**, **51<sub>3</sub>**, **51<sub>4</sub>**, **52<sub>1</sub>**, **52<sub>2</sub>**, **52<sub>3</sub>**, **52<sub>4</sub>**. A plurality of these conductors are wound in a first direction (e.g., clockwise) and braided with the remaining conductors that are wound in a second direction opposing the first direction (e.g., counter clockwise). FIG. **4** illustrates each braid member including two parallel wound and separated individual insulated conductors, however each braid member can include just a single separated individual insulated conductor or more than two parallel wound separated individual insulated conductors, as desired.

In the exemplary embodiment illustrated, a first braid member include a first two parallel wound separated individual insulated conductors **51<sub>1</sub>**, **51<sub>2</sub>** and a second braid member is parallel wound and includes a second two parallel wound separated individual insulated conductors **51<sub>3</sub>**, **51<sub>4</sub>**. A third and fourth braid member is wound in an opposing direction to the winding direction of the first and second braid members. The third braid member include a third two parallel wound separated individual insulated conductors **52<sub>1</sub>**, **52<sub>2</sub>** and a fourth braid member is parallel wound and includes a fourth two parallel wound separated individual insulated conductors **52<sub>3</sub>**, **52<sub>4</sub>**.

While the illustrated embodiment includes four braid members where each braid includes 2 insulated electrical conductors equaling a total of eight insulated electrical conductors, the braided coil can include any useful number of insulated electrical conductors such as, for example, from 3 to 16, or from 4 to 16, or from 4 to 16, as desired.

The insulated conductors described above that form the braided coil **50** can have any useful diameter and the braided coil **50** can have any useful diameter such as, for example 0.5 to 3 millimeters, or from 0.5 to 2 millimeters, or from 0.5 to 1 millimeter. In some exemplary embodiments, the electrical conductors have a diameter or thickness in a range from 50 to 250 micrometers, or from 100 to 150 micrometers and the insulator layer can add from 15 to 50 micrometers to the electrical conductor diameter or thickness. Thus, in many embodiments, the insulated electrical conductors have a diameter or thickness in a range from 65 to 300 micrometers, or from 115 to 200 micrometers. The insulator layer can be formed of any useful electrically insulating material such as, for example, a polymeric material. In some embodiments, the electrically insulating material includes silicone.

In many embodiments, the electrical conductors and/or the insulated electrical conductors **51<sub>1</sub>**, **51<sub>2</sub>**, **51<sub>3</sub>**, **51<sub>4</sub>**, **52<sub>1</sub>**, **52<sub>2</sub>**, **52<sub>3</sub>**, **52<sub>4</sub>** used to form the braided coil **50** have the same or substantially the same diameter or thickness. In many embodiments, the insulated electrical conductors **51<sub>1</sub>**, **51<sub>2</sub>**, **51<sub>3</sub>**, **51<sub>4</sub>**, **52<sub>1</sub>**, **52<sub>2</sub>**, **52<sub>3</sub>**, **52<sub>4</sub>** have a circular cross-sectional profile, however in some embodiments, the insulated electrical conductors **51<sub>1</sub>**, **51<sub>2</sub>**, **51<sub>3</sub>**, **51<sub>4</sub>**, **52<sub>1</sub>**, **52<sub>2</sub>**, **52<sub>3</sub>**, **52<sub>4</sub>** have a rectangular cross-sectional profile. In these embodiments the insulated electrical conductors can have an aspect ratio (thickness:width) in a range from 1:1 to 1:20 or from 1:2 to 1:10.

The lead body **40** extends between a proximal end **42** and a distal end **41**. As shown in FIG. 3 and FIG. 5, stimulating electrodes **26** are located at the distal end **41** and contacts **25** are located at the proximal end **42**. Each insulated electrical conductor **51<sub>1</sub>**, **51<sub>2</sub>**, **51<sub>3</sub>**, **51<sub>4</sub>**, **52<sub>1</sub>**, **52<sub>2</sub>**, **52<sub>3</sub>**, **52<sub>4</sub>** used to form the braided coil **50** can be addressed between a single contact **25** and a single electrode **26** such that each electrode **26** can be individually activated via the contact and a single insulated electrical conductor.

Thus, exemplary embodiments of the EXTENSIBLE IMPLANTABLE MEDICAL LEAD WITH BRAIDED CONDUCTORS are disclosed. One skilled in the art will appreciate that the present disclosure can be practiced with other embodiments. The disclosed embodiments are presented for purposes of illustration and not limitation, and the present disclosure is limited only by the claims that follow.

What is claimed is:

1. An extensible implantable electrical lead comprising:  
a lead body having a proximal end and a distal end, the lead body formed of a polymeric material that is extensible between a first length and a second length, the second length being at least 10% greater than the first length; and

a plurality of electrical conductors disposed within the lead body and extending between the proximal end and the distal end, the plurality of electrical conductors forming a braided coil extending between the proximal end and the distal end and defining a diameter, the plurality of electrical conductors being electrically insulated and separated from each other, the diameter being a first diameter when the lead body has the first length and a second diameter when the lead body has the second length, the second diameter being less than the first diameter;

wherein the lead body comprises an inner sheath disposed within a lumen formed by the braided coil, and the braided coil is disposed within an annulus between an outer sheath and the inner sheath, wherein the inner sheath and the outer sheath are coaxial;

wherein a first set of the plurality of electrical conductors are wound in a clockwise direction around the lumen of the braided coil and a second set of the plurality of electrical conductors are wound in a counterclockwise direction around the lumen of the braided coil.

2. An extensible implantable electrical lead according to claim 1, wherein the plurality of insulated electrical conductors each have substantially the same outer diameter.

3. An extensible implantable electrical lead according to claim 1, wherein the second length is at least 20% greater than the first length.

4. An extensible implantable electrical lead according to claim 1, wherein the second length is at least 25% greater than the first length.

5. An extensible implantable electrical lead according to claim 1, wherein at least selected insulated electrical conductors have a rectangular cross-sectional profile.

6. An extensible implantable electrical lead according to claim 1, wherein the polymeric material comprises silicone.

7. An extensible implantable electrical lead according to claim 1, wherein the plurality of electrical conductors is from four to sixteen electrical conductors.

8. An extensible implantable electrical lead according to claim 1, wherein the lead body further comprises a plurality of contacts at the distal end of the lead body and each electrical conductor connects a single distal end contact or electrode with a proximal end contact.

9. An extensible implantable electrical lead according to claim 1, wherein the braided coil comprises two insulated electrical conductors for each braid element.

10. An extensible implantable electrical lead according to claim 1, wherein a first plurality of the electrical conductors are wound in a clockwise direction and a second plurality of the electrical conductors are wound in a clockwise direction and a third plurality the electrical conductors are wound in a counter clockwise direction and a fourth plurality of electrical conductors are wound in a counter clockwise direction.

11. An extensible implantable electrical lead according to claim 1, wherein a first braid member includes two electrical conductors adjacent one another that are insulated from each other, the first braid member wound in a clockwise direction to form part of the braided coil, and a second braid member includes two electrical conductors adjacent one another that are insulated from each other, the second braid member wound in a clockwise direction parallel to the first braid member to form part of the braided coil, and a third braid member includes two electrical conductors adjacent one another that are insulated from each other, the third braid member wound in a counter clockwise direction to form part of the braided coil, and a fourth braid member includes two electrical conductors adjacent one another that are insulated from each other, the fourth braid member wound in a counter clockwise direction parallel to the third braid member to form part of the braided coil.

12. An implantable neurostimulation system comprising a neurostimulating device; and

an extensible electrical lead electrically coupled to the neurostimulating device, the extensible electrical lead electrically comprising:

a lead body having a proximal end and a distal end, the lead body formed of a polymeric material that is extensible between a first length and a second length, the second length being at least 10% greater than the first length; and

a plurality of electrical conductors disposed within the lead body and extending between the proximal end and

the distal end, the plurality of electrical conductors forming a braided coil extending between the proximal end and the distal end, the plurality of electrical conductors being electrically insulated and separated from each other, the diameter being a first diameter when the lead body has the first length and a second diameter when the lead body has the second length, the second diameter being less than the first diameter;

wherein the lead body comprises an inner sheath disposed within a lumen formed by the braided coil, and the braided coil is disposed within an annulus between an outer sheath and the inner sheath, wherein the inner sheath and the outer sheath are coaxial;

wherein a first set of the plurality of electrical conductors are wound in a clockwise direction around the lumen of the braided coil and a second set of the plurality of electrical conductors are wound in a counterclockwise direction around the lumen of the braided coil.

**13.** An implantable neurostimulation system according to claim **12**, wherein the extensible electrical lead is a lead extension that electrically couples the neurostimulating device to a proximal end of a lead having a plurality of contacts at a distal end of the lead.

**14.** An implantable neurostimulation system according to claim **12**, wherein the braided coil comprises two insulated electrical conductors adjacent one another for each braid element.

**15.** A method comprising:  
 applying a force of 5 N or less to a proximal end and a distal end of an extensible electrical lead having a first length, the force increasing the first length of the extensible electrical lead by at least 10%, the electrical lead comprising:  
 a lead body having a proximal end and a distal end, the lead body formed of a polymeric material that is

extensible between a first length and a second length, the second length being at least 10% greater than the first length; and

a plurality of electrical conductors disposed within the lead body and extending between the proximal end and the distal end, the plurality of electrical conductors forming a braided coil extending between the proximal end and the distal end, the plurality of electrical conductors being electrically insulated and separated from each other, the diameter being a first diameter when the lead body has the first length and a second diameter when the lead body has the second length, the second diameter being less than the first diameter, wherein a first set of the plurality of electrical conductors are wound in a clockwise direction around the lumen of the braided coil and a second set of the plurality of electrical conductors are wound in a counterclockwise direction around the lumen of the braided coil; and

removing the force from the extensible electrical lead to return the extensible electrical lead to its first length and the first length braided coil diameter.

**16.** A method according to claim **15**, wherein the applying step increases the first length by at least 20%.

**17.** A method according to claim **15**, wherein the applying step increases the first length by at least 25%.

**18.** A method according to claim **15**, further comprising implanting the extensible electrical lead in a patient.

**19.** A method according to claim **15**, wherein the braided coil comprises two insulated electrical conductors adjacent one another for each braid element.

**20.** A method according to claim **15**, wherein the lead body comprises an inner sheath disposed within a lumen formed by the braided coil and an outer sheath surrounding the braided coil, and the inner sheath and the outer sheath are separated from each other, and the inner sheath and outer sheath are coaxial.

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